Design Guide
to AMP Coaxial Taps

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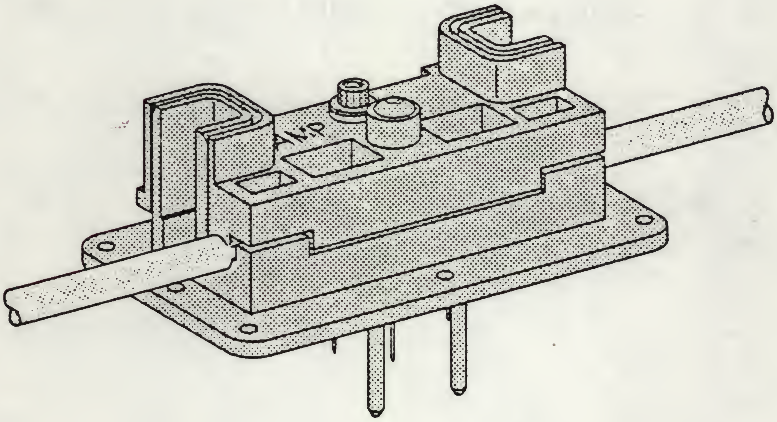
DESIGN GUIDE
TO
AMP★ COAXIAL TAPS



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1. INTRODUCTION

A significant trend in modern communications and information processing is the growing popularity of local area networks based on a coaxial-cable bus. A network allows data-generating and data-receiving equipment to communicate with each other over the bus. It promotes distributed processing by permitting large and small computers, computer peripherals, and other intelligent equipment stations to be joined by the bus. A typical network can contain up to 256 stations connected by 1000 feet of coaxial cable and operating at speeds of 5 to 10 megabaud. Figure 1 shows a typical network.

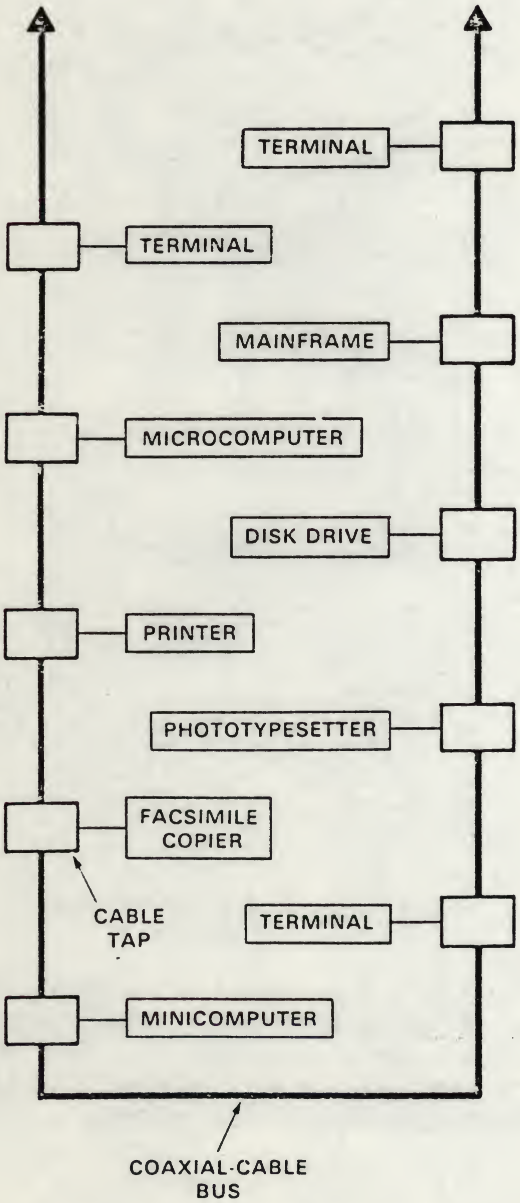


Fig. 1. A Typical Local Network

The growth of networks also brings a need for a fast, reliable means of tapping the cable to add stations. Traditional methods, such as N series rf connectors or CATV-style taps, have some drawbacks that make their use unattractive. Figure 2 shows these two methods of tapping a cable. Although rf connectors provide high performance, their use requires that the cable be cut for installation to allow the connectors and transceiver board to be inserted. Cutting the cable means that the entire network must be shut down simply to add a station. Such shutdowns are potentially disruptive and can result in the loss of critical data passage on the bus. Thus a shutdown requires scheduling with all users of the network. In addition, applying the connector requires careful cable preparation and termination by a skilled technician.

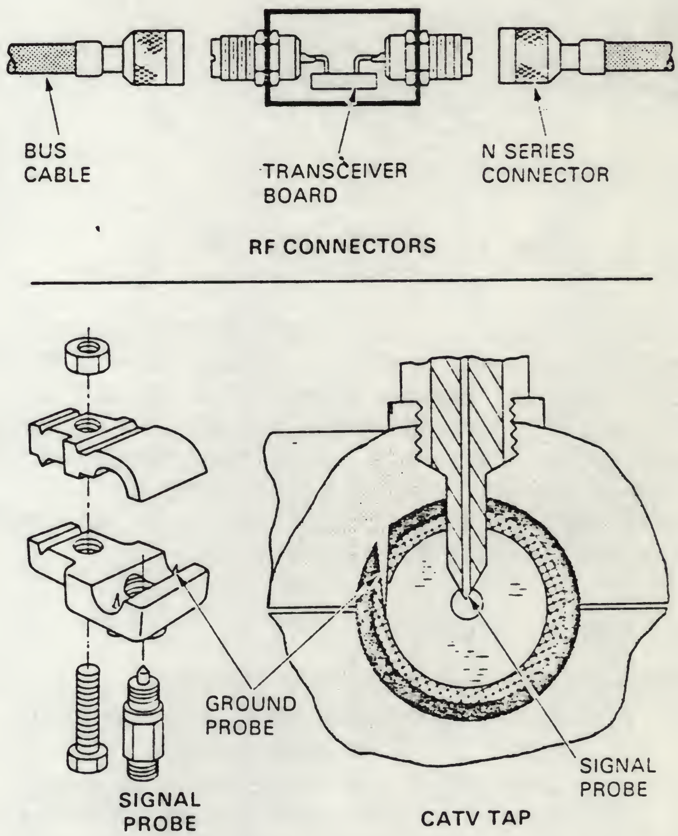


Fig. 2. Traditional Methods of Tapping a Cable

CATV-style taps also find use. These taps use a single probe to make contact with the cable's center conductor. While the tap is easily applied and does not require the network be shut down, long-term reliability is a problem, especially considering the needs of data processing. The probe presses against one side of the center conductor. Since there is no mechanism to hold the conductor against the probe,

the conductor may eventually drift away from the probe. The result is intermittencies or complete loss of contact. In either case, the integrity of the network is degraded.

The AMP coaxial tap, shown in Figure 3, offers an attractive alternative to rf connectors or CATV taps in local networks. The AMP tap combines the reliable performance of an rf connector with the easy installation of a CATV tap. It may be installed while the network is operating. Installation is usually a two-step process: the cable is placed in a fixture and holes for the probes are drilled; the tap is then placed on the cable, and two screws are tightened to complete the tap. At times, the tap may be applied without first drilling the cable. The necessity of drilling depends on the type of cable.

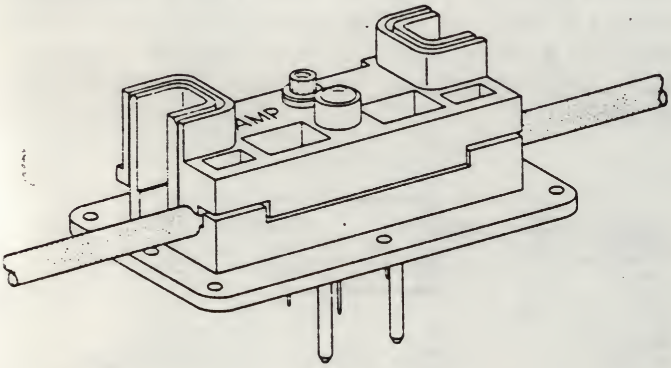


Fig. 3. AMP Coaxial Tap

As easy as the tap is to apply, users must be aware of the factors involved in selecting tap and cable. Cable construction is important to the proper operation of the tap. This guide describes the tap, details the specification the coaxial cable must meet, and presents general guidelines for using the tap. Understanding these factors will help ensure troublefree use of the AMP coaxial tap.

2. TAP DESCRIPTION

The AMP coaxial tap has three main parts:

1. A two-piece glass-filled polyester body with a 94V-O flammability rating.
2. A set of probes that contact the center conductor. One probe is fixed and makes electrical connection with the conductor. The other probe is a spring-loaded backup that ensures long-term reliability.
3. A set of terminators for the shield. The terminators supply the signal-return connection.

Figure 4 shows the parts of the tap. The cable rests in a channel running the length of the tap. The shield terminators are located in the bottom of the channel. As the top body is tightened against the bottom body, the terminators pierce the cable's insulation. The cable curvature and the design of the channel deform the terminators enough to "crimp" the cable braid between their mechanically active prongs. The two terminators provide four pairs of redundant contacts.

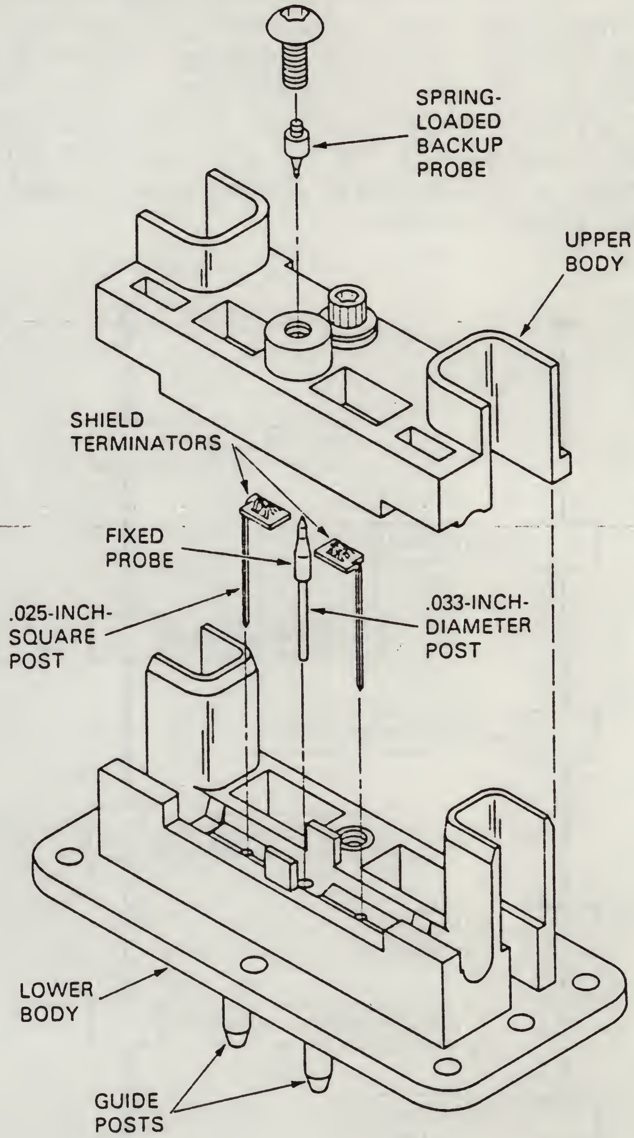


Fig. 4. Parts of the AMP Tap

The center conductor probes extend from the top and bottom of the tap to make contact with both sides of the center conductor. The fixed bottom probe is used to tap the electrical signal. The spring-loaded upper backup probe provides a residual

stored-energy connection to promote long-term reliability. The result is a mechanically active termination, since the backup probe remains under spring pressure. Both probes have their length insulated; their tips are exposed metal to provide electrical contact and prevent braid/foil drag-down.

Figure 5 shows cross sections of the center conductor and shield connections.

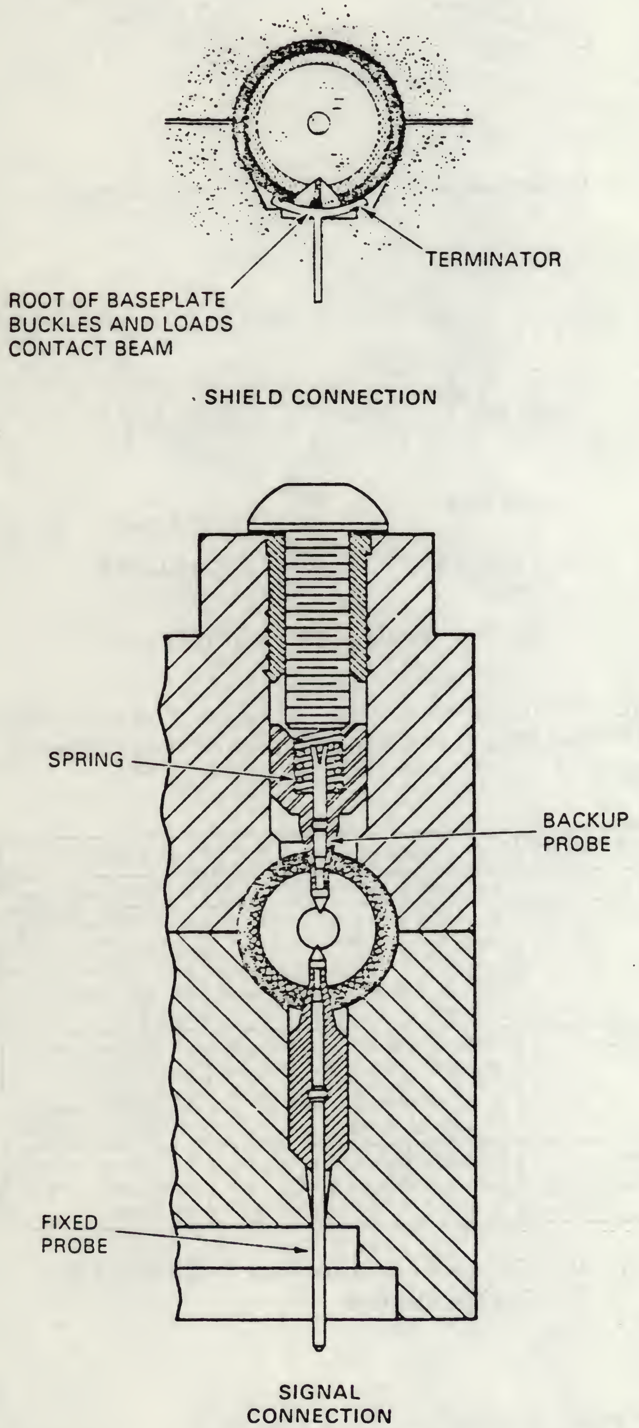


Fig. 5. Cross Sections of Terminations

The tap is designed for flange mounting to a transceiver housing. The transceiver board interfacing the bus to the station connects to the bottom of the tap. Extending from the tap's bottom are two plastic guide posts and three metal electrical posts. The guide posts aid alignment when tap and board are mated. The two outer electrical posts are the terminators supplying the signal-return connections. The center post is the fixed probe supplying the signal connection. Signal-return posts are 0.025 inch square; the center signal post has a diameter of 0.033 inch (corresponding to the diagonal of a .025 square post). The mating length of the posts is a minimum of 0.470 inch.

As shown in Figure 6, the pc board can be connected to the tap by edge mounting or surface mounting. Receptacles mounted on the board are used to mate with the posts. Recommended receptacles are AMPMODU ★ Type A receptacles 87758-1 or 87768-1 for surface mounting or AMPMODU Type C receptacles 85863-4 or 85866-4 for edge mounting.

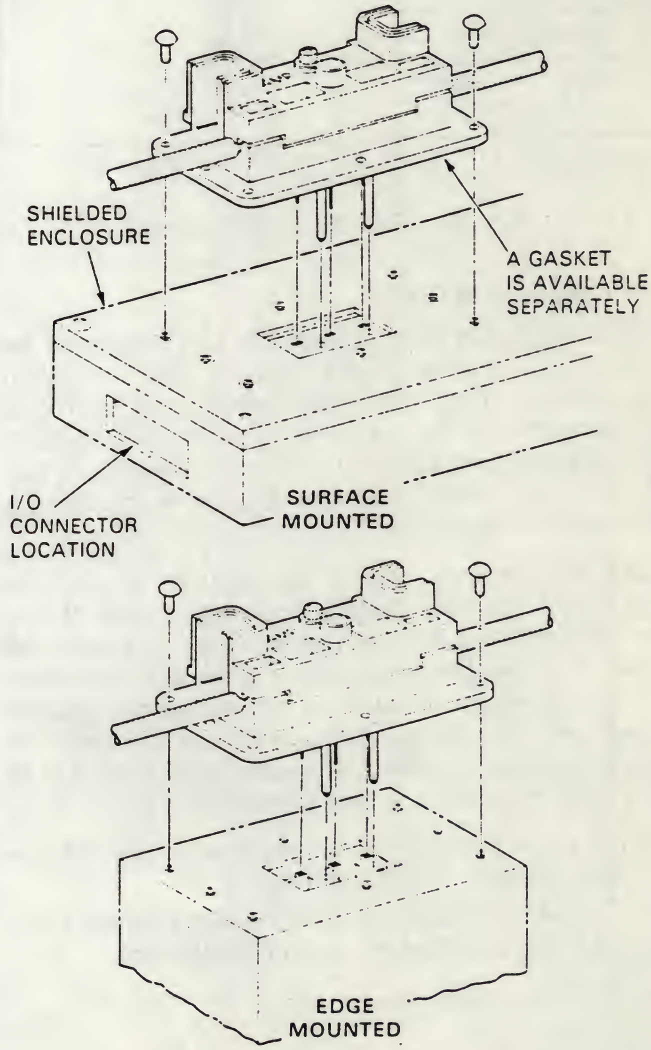


Fig. 6. Surface-Mounted and Edge-Mounted PC Boards

The AMP coaxial tap is currently available in three versions: one for cable with a 14 AWG center conductor, one for cable with a 10 AWG center conductor, and one for Ethernet* cable, which has a 0.0855-inch-diameter center conductor. Figure 7 lists the three available taps. The taps are identical except for the probes. Taps are reusable, although shield terminators *must* be replaced. Replacement of center-conductor probes is optional and depends on whether they have been bent or broken.

TAP PART NUMBER	CENTER CONDUCTOR	REPLACEMENT PROBE SET PART NUMBER	REPLACEMENT TERMINATOR PART NUMBER
228105-1	14 AWG	228328-1	227959-3
228105-3	10 AWG	228329-1	
228105-4	0.0855 (Ethernet)	228330-1	

Fig. 7. Available AMP Coaxial Taps

Figure 8 lists specifications for the taps.

Operating Cable Voltage (max)	50 Vdc or Vac_{rms}
Operating Tap Voltage (max)	600 Vdc or Vac_{rms}
Capacitance (max)	3 pF (on drilled cable)
Contact Resistance (max)	50 mΩ
Contact Current Rating (max)	1 A
Insulation Resistance (min)	5 GΩ
Cable Retention (min)	150 lb
Cable Torque Resistance (min)	20 in.-lb
Operating Temperature	0 to 50°C
Storage Temperature	- 30 to 80°C

NOTE: FOR TEST METHODS AND FURTHER SPECIFICATIONS, SEE THE AMP PRODUCT SPECIFICATION.

Fig. 8. Tap Specifications

3. CABLE CRITERIA

In selecting cable for use with the tap, you must be aware of several dimensional and physical requirements that the cable must meet. These requirements can be met by a large number of commercially available cables from many vendors; nevertheless, you *should be sure* the cable meets the requirements given here.

Cable requirements depend on whether or not you plan to drill the cable before applying the tap. If you wish to apply the tap without drilling the cable, the cable materials become more significant, since the tap probes must be able to penetrate the jacket, shield, and dielectric. Wrong materials can result in bent or damaged probes, or shorts. If the cable is to be drilled, materials are less critical.

For any application, the cable must always meet the following material requirements:

Center Conductor: *Solid* annealled copper of the wire size required by the particular tap.

* TRADEMARK OF THE XEROX CORPORATION

Dielectric: Plastic, such as polyethylene or Teflon* TFE or FEP.

Shield: Braid or foil, with up to four layers. *The outer layer must be braided,* tin-plated copper 32 through 36 AWG.

Jacket: Plastic. The outer diameter must be between 0.370 and 0.410 inch to ensure the cable will be firmly held by the tap.

Figure 9 shows typical coaxial cables.

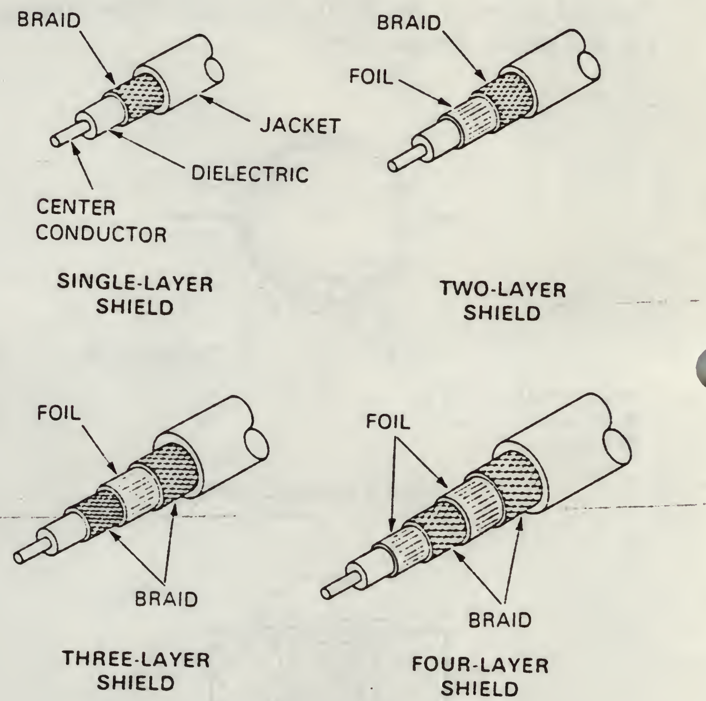


Fig. 9. Typical Coaxial Cables

If you do not wish to drill the cable, you must use cable that meets the material requirements listed in Figure 10.

CABLE PART	MATERIALS	REMARKS
Conductor	Solid annealled copper	No plating required
Dielectric	Solid or foamed polyolefin (polyethylene, etc) Solid or foamed fluoropolymer (Teflon*, etc)	Foam plastics *cannot* be used if the cable has a double-layer shield (on 50-Ω cable).
SHIELD	Up to two layers — one braid and one foil Braid: tin-plated copper 32 through 36 AWG	Outer layer must be braid. Foil should have less than 10% elongation.
Jacket	Polyolefin, fluoropolymer, or polyvinyl chloride (PVC)	Outer diameter must be between .370 and .410 inch.

Fig. 10. Cable Requirements If Cable Is Not To Be Drilled

* TRADEMARK OF E.I. DU PONT DE NEMOURS & CO.

Particular attention must be paid to the shield. The probe may drag parts of the braid or foil inward to short them against the center conductor. This shorting is the main cause of failure in using the tap if the cable is not first drilled. Even if the cable is made of the materials listed in Figure 10, proper performance of the tap is not ensured unless you perform a penetrability test to ensure that the probes can penetrate the cable without bending or shorting the shield against the center conductor. The penetrability test is described in Section 5 of this guide.

An ideal coaxial cable is concentric, with all layers having a common axis. In a real cable, manufacturing tolerances introduce some eccentricity into the cable. For the tap to work properly, eccentricity must be within certain limits. For example, if the center conductor is sufficiently off center, the probes may bend or may completely miss the center conductor during tapping. AMP has devised three equations to ensure that the cable falls within the eccentricity limits required by the tap. Figure 11 shows the eccentricity requirements.

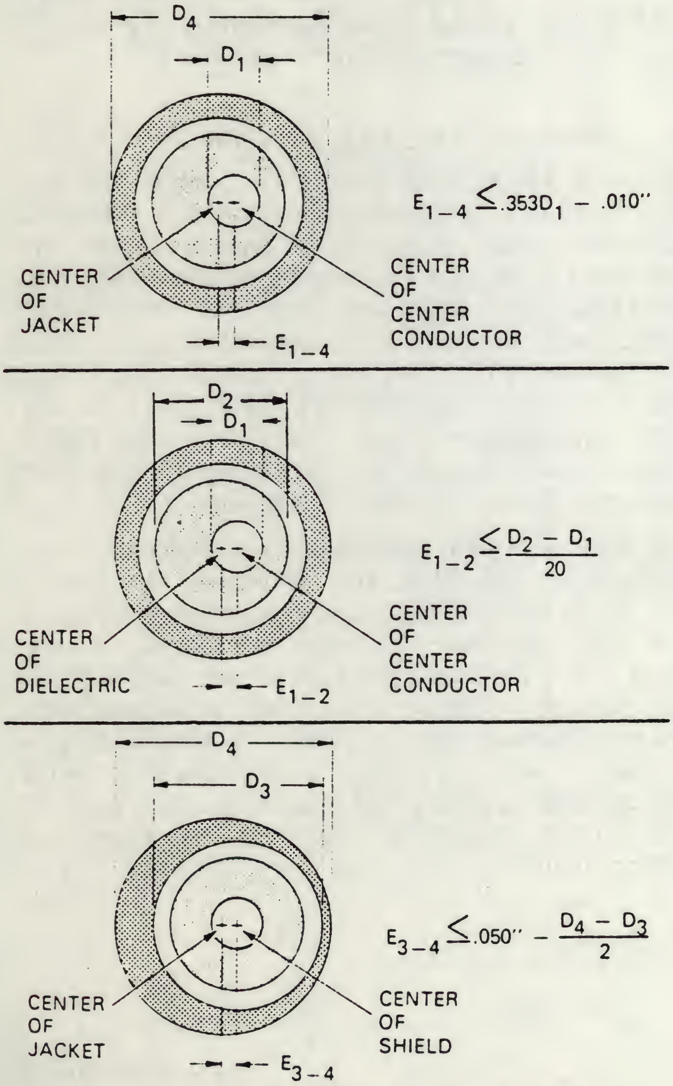


Fig. 11. Cable Eccentricity Limits

A. Center-Conductor-to-Jacket Eccentricity

The difference between the center of the center conductor and the center of the jacket must be less than or equal to the following:

$$E_{1\text{-}4} \leq .353\ D_1 - .010''$$

where D_1 is the diameter of the center conductor.

B. Center-Conductor-to-Dielectric Eccentricity

The difference between the center of the center conductor and the center of the dielectric must be less than or equal to the following:

$$E_{1\text{-}2} \leq \frac{D_2 - D_1}{20}$$

where D_1 is the diameter of the center conductor and D_2 is the diameter of the dielectric.

C. Shield-to-Jacket Eccentricity

The difference between the center of the shield and the center of the jacket must be less than or equal to the following:

$$E_{3\text{-}4} \leq .050'' - \left(\frac{D_4 - D_3}{2}\right)$$

where D_3 is the outer diameter of the shield and D_4 is the diameter of the jacket.

The following is an example of how these calculations work for a typical cable. Figure 12 shows the cable, its dimensions and its limits of eccentricity. The cable has the following dimensions:

Center conductor:	0.0855 inch diameter
Dielectric:	0.242 inch outer diameter
Shield:	0.326 inch outer diameter
Jacket:	0.405 inch outer diameter

A. Center-conductor-to-jacket eccentricity has a maximum dimension of .0202 inch:

$$E_{1\text{-}4} \leq .353\ (.0855) - .010''$$
$$\leq .0202$$

B. Center-conductor-to-dielectric eccentricity has a maximum dimension of .0078 inch:

$$E_{1\text{-}2} \leq \frac{.242 - .0855}{20}$$
$$\leq .0078$$

C. Shield-to-jacket eccentricity has a maximum dimension of .0105 inch:

$$E_{3\text{-}4} \leq .050 - \left(\frac{.405 - .326}{2}\right)$$
$$\leq .0105$$

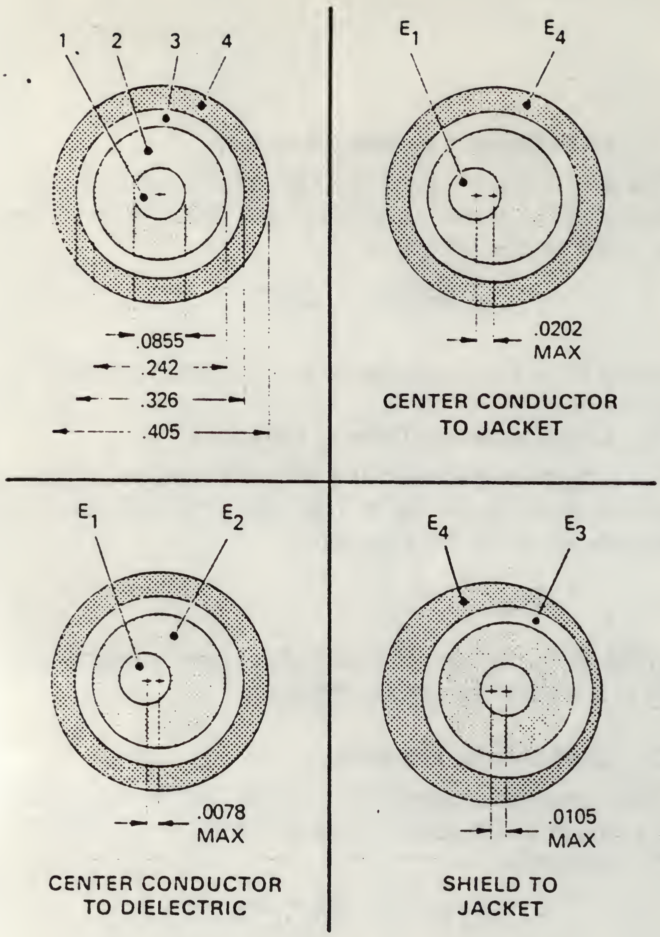


Fig. 12. Eccentricity Examples

The cable must meet all three eccentricity requirements at the same time.

To show the importance of cable requirements, Figure 13 is a series of cross sections showing both correct and incorrect cable taps.

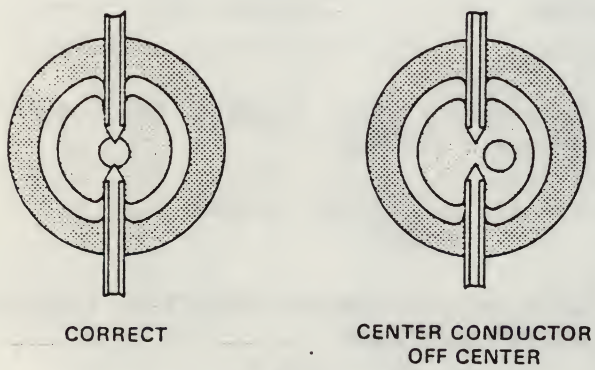


Fig. 13. Cross Sections of Typical Correct And Incorrect Taps

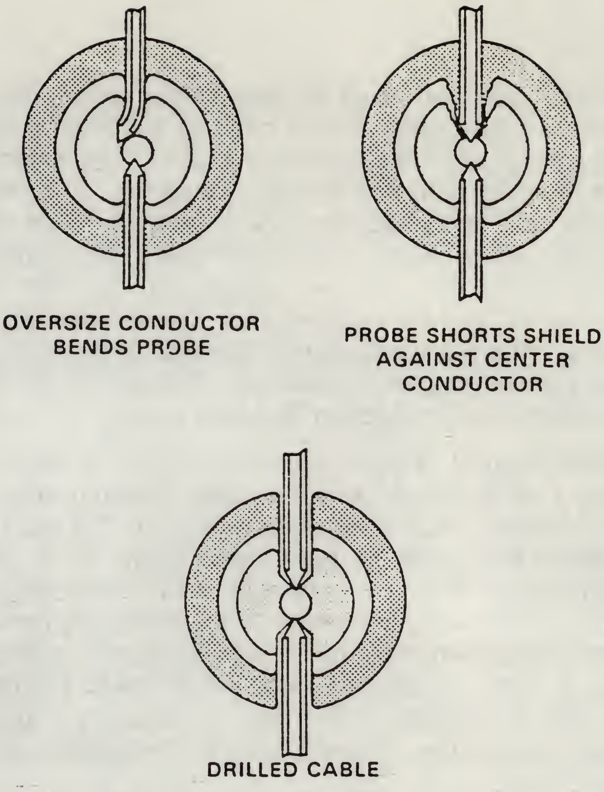
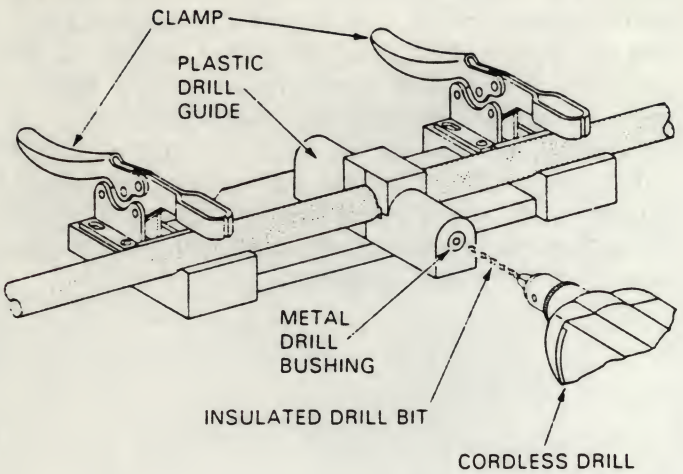


Fig. 13. (Cont) Cross Sections of Typical Correct And Incorrect Taps

4. APPLYING THE TAP — WITH DRILLING

Although drilling involves an extra operation in tapping a cable, it has several advantages. It maintains consistent capacitance values and eliminates the possibility of the probes dragging the shield inward to short against the center conductor. Even if an undrilled shield does not touch the center conductor, it may still be dislocated more than it will be in a drilled cable. Greater dislocation (since it changes the cable's geometry) increases capacitive loading. Drilled cables present much less capacitive loading than undrilled cables — typically 2.5 pF versus 5 pF.

The tap is applied in two steps. First, a drilling fixture is placed on the cable. The fixture has two clamps that firmly hold the cable and prevent its twisting. A drill guide fits into the fixture and snaps over the cable. The guide has a drill hole in each side to guide the drill bit. A specially insulated bit is used; the insulation isolates the cable from the drill and acts as a stop on the drilling depth. The purpose of drilling is to locally remove the shield to provide a clear path for the center-conductor probes. Figure 14 shows the drilling fixture.



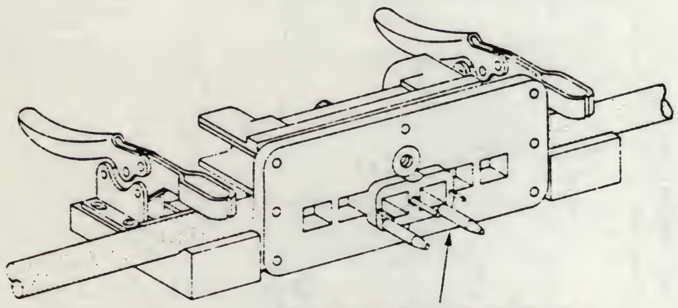
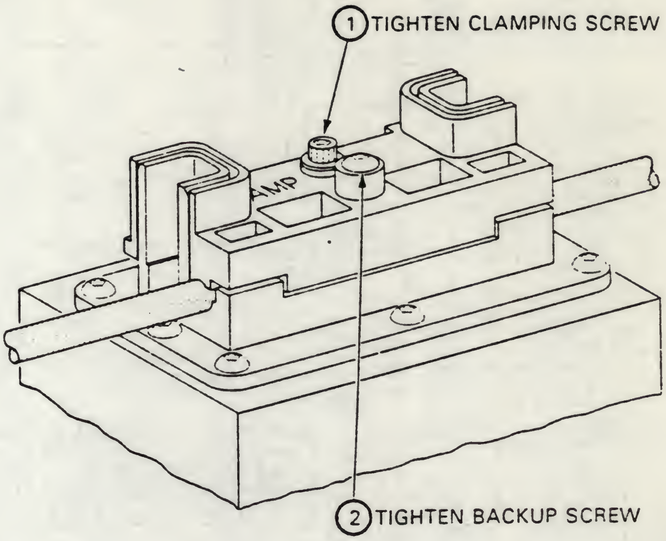


Fig. 14. **Drilling Fixture**

After the cable is drilled, the plastic drill guide is removed from the cable and strap fixture. The fixture is left on the cable. The strap fixture is keyed to the tap. When the tap is placed on the fixture, the *probes are precisely aligned* with the drilled holes in the cable.

Completing the tap is simply a matter of tightening two screws. See Figure 15. First, the clamping screw tightens the upper body against the lower. At this time, the terminators "crimp" the cable braid and the fixed probe penetrates the cable to the center conductor. Next, the backup screw is tightened to bring the backup probe into contact with the opposite side of the center conductor. The tap is complete. Finally, the fixture is removed, and the tapping process is complete. Typical tapping times are less than five minutes.

AMP offers an application kit (part number 228410-1) containing all items required to perform the tapping operation: drilling fixture, drill guide, drill bits, a



NOTE: DRILL FIXTURE NOT SHOWN IN PLACE ON TAP.

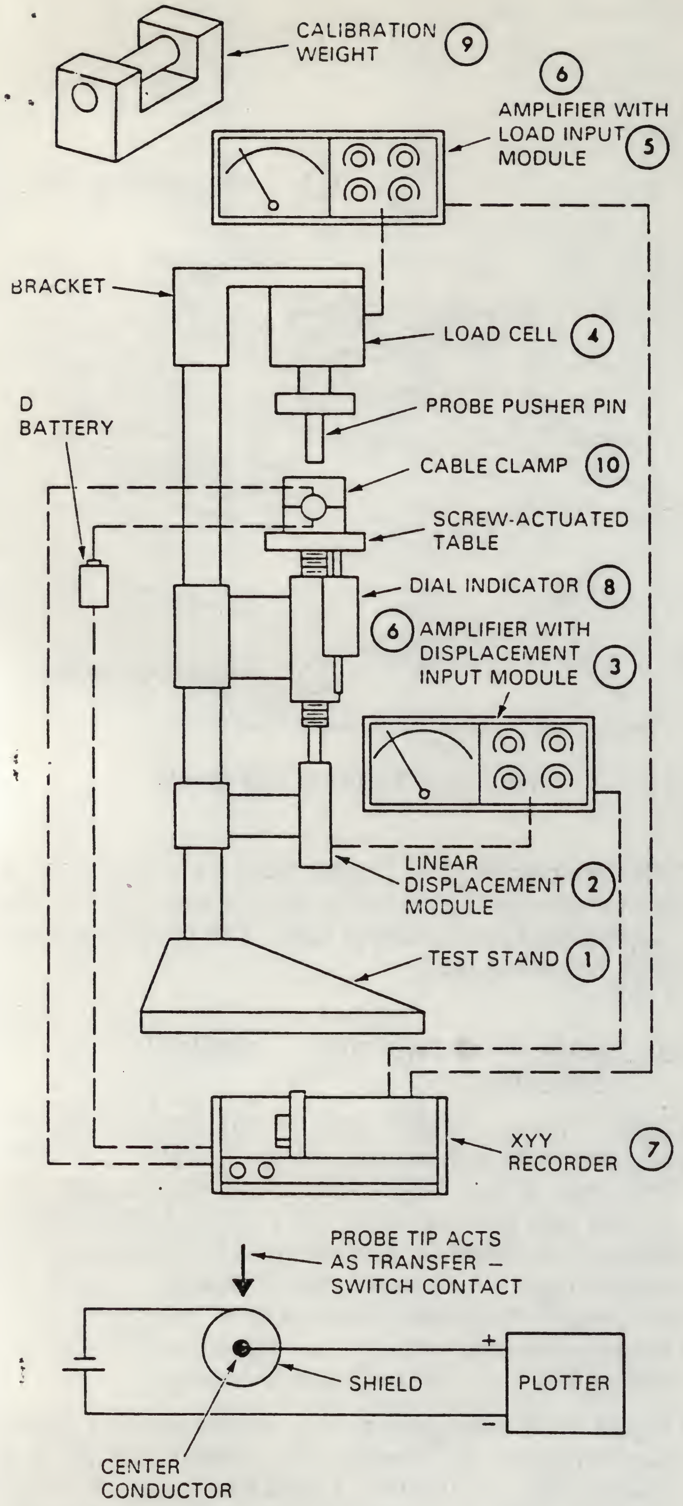
Fig. 15. **Tapping the Cable**

cordless electric drill, a drill charger, a wrench, and a packet of braid terminators. All items are housed in a rugged field-service-grade case. The kit can be used with any AMP taps.

5. APPLYING THE TAP — WITHOUT DRILLING

Some types of cable can be successfully tapped without drilling them first. Nevertheless, a penetration test should be performed to ensure that the probes can penetrate the cable without either intermittent or continuous shorting. The test measures penetration force versus probe travel, as well as showing if the shield shorts against the center conductor. The test provides a "signature analysis" of the cable's ability to be properly tapped.

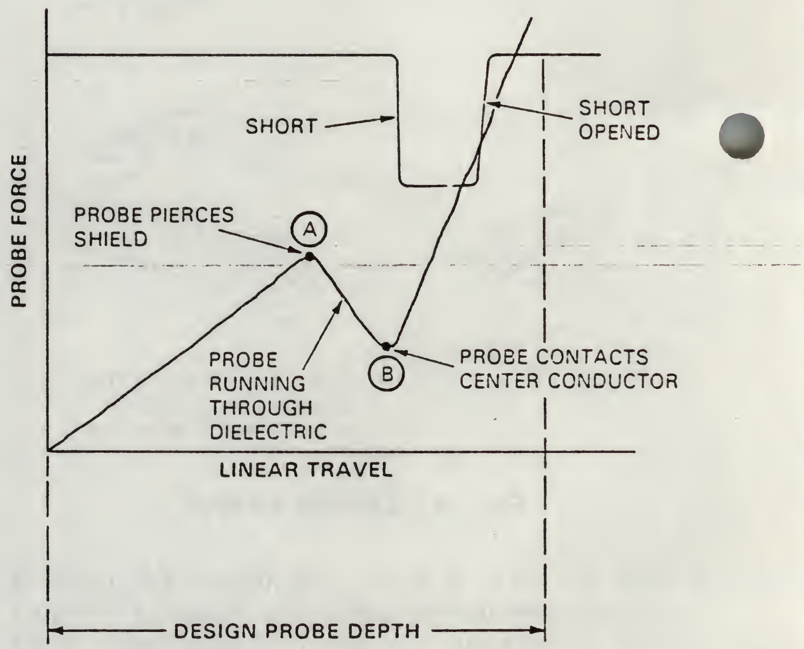
Figure 16 is a diagram of the test setup and a list of recommended equipment. The cable is placed in a special test fixture that simulates a tap. A single probe is in the top section of the fixture. The cable-clamp fixture rests on a linear displacement tranducer; above the fixture is a pressure transducer used to measure penetration force of the probe. As the probe displaces the cable materials, an X-Y plotter graphs probe travel versus penetration force. It also plots an electrical circuit used to detect shorts through circuit continuity. The resulting graph is used to determine whether the tap can be applied without drilling the cable.



EQUIPMENT	MANUFACTURER AND MODEL
1. Test Stand	Hunter CTM
2. Linear Displacement Module	Daytronic DF 160
3. Displacement Input Module	Daytronic Type 70
4. Load Cell	Daytronic 152A (100 lb)
5. Load Input Module	Daytronic Type 71
6. Amplifiers (2)	Daytronic 300D
7. XYY Recorder	Hewlett-Packard 7046A
8. Dial Indicator	Federal D815
9. Calibration Weights	
10. Cable Clamp	

Fig. 16. Penetration Test Setup

Figure 17 is a typical penetration-test graph. As the probe enters the cable and encounters the shield, the force increases. When the probe breaks through the shield, the pressure drops until the probe reaches the center conductor, at which time it increases again. The line across the top of the graph represents the electrical circuit. The circuit consists of a battery, cable, probe, and plotter. The cable shield and center conductor are connected in series in the circuit. When the shield is shorted against the center conductor by the metal probe tip, the circuit to the plotter is shunted; the line on the chart will show a sharp drop until the shunt is opened.



NOTE
– MINIMUM REQUIRED DISTANCE A-B IS .060

Fig. 17. Graph for Penetration Test

If the cable samples can consistently be penetrated without causing sustained shorts, you can apply the tap without drilling the cable. If this is not the case, AMP recommends that the cable be drilled, since without drilling, cable/tap performance cannot be ensured.

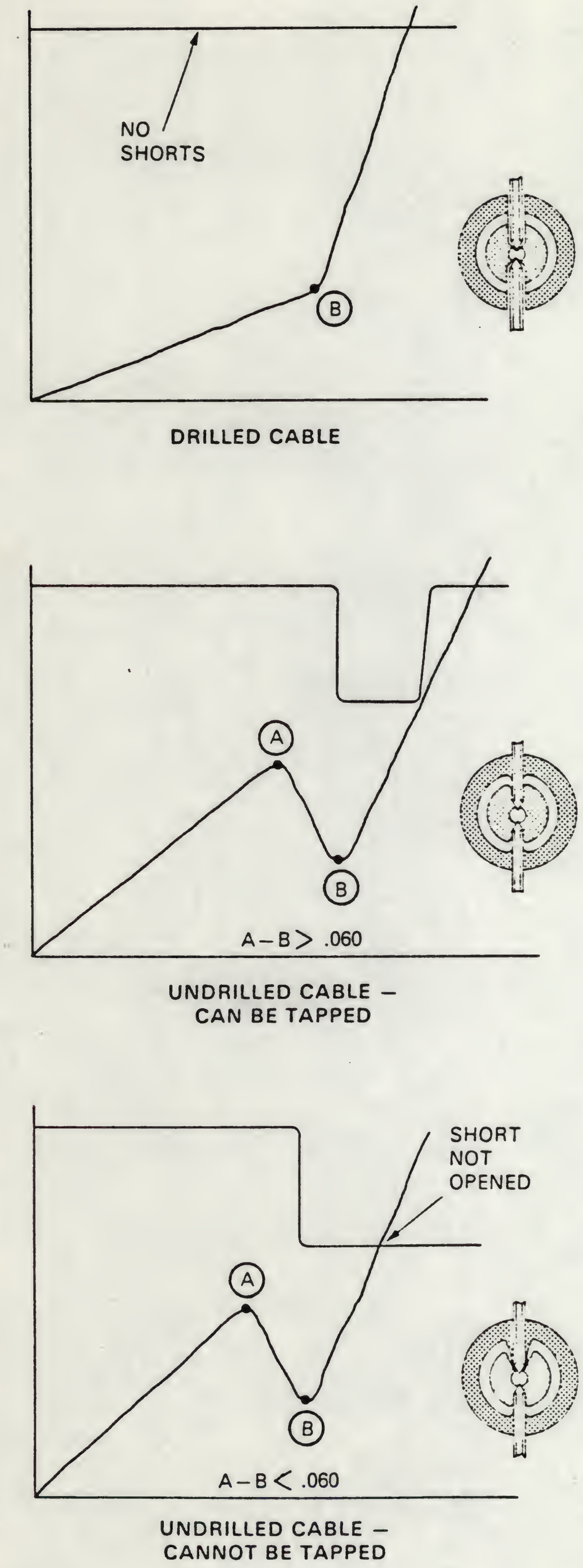


Fig. 18. Typical Penetration Graphs

6. CONCLUSION

The AMP coaxial tap is an efficient, reliable means of tapping a coaxial cable in a local area network. This design guide has described the tap and detailed the material and dimensional requirements of the cable. By carefully following the guidelines presented here, you should have reliable, troublefree use of the tap.

For further information on the tap, see your local AMP representative, or write or call

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